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H4D

Selected US specifications from IPC sub-classes

F41G G01S

(54) Missile guidance

(57) A missile guidance system makes use of an optical guide-beam projector which provides a spatially intensity modulated guide-beam. To produce the guide beam a "phase diaphragm" (i.e. a transparent plate which imparts a phase shift 3 to the beam which varies with the position of the beam on the plate) 2 is used. The phase modulation is converted into an amplitude modulation by lenses 4, 6 and phase plate 5 and the amplitude or intensity profile 7 which is produced is projected into space by lens 8.

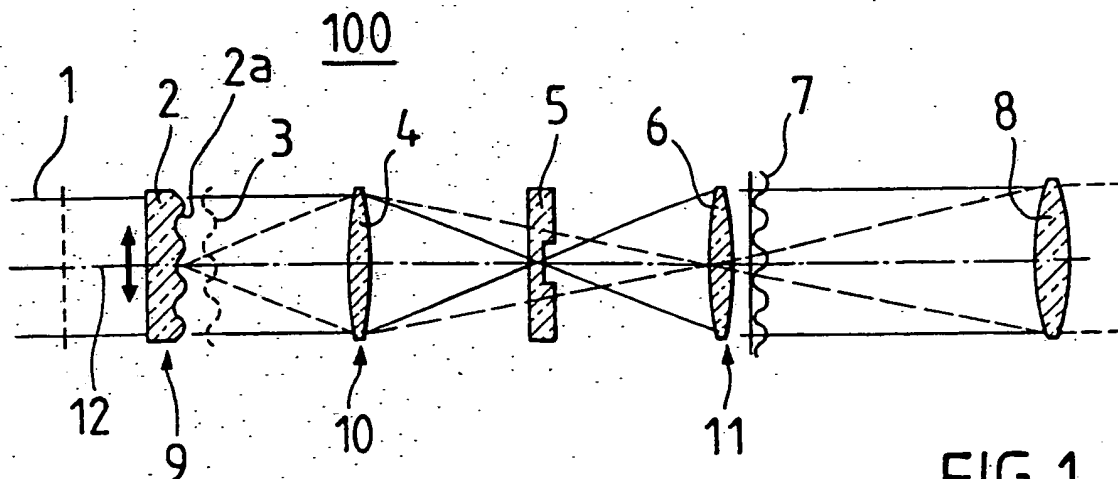


FIG. 1

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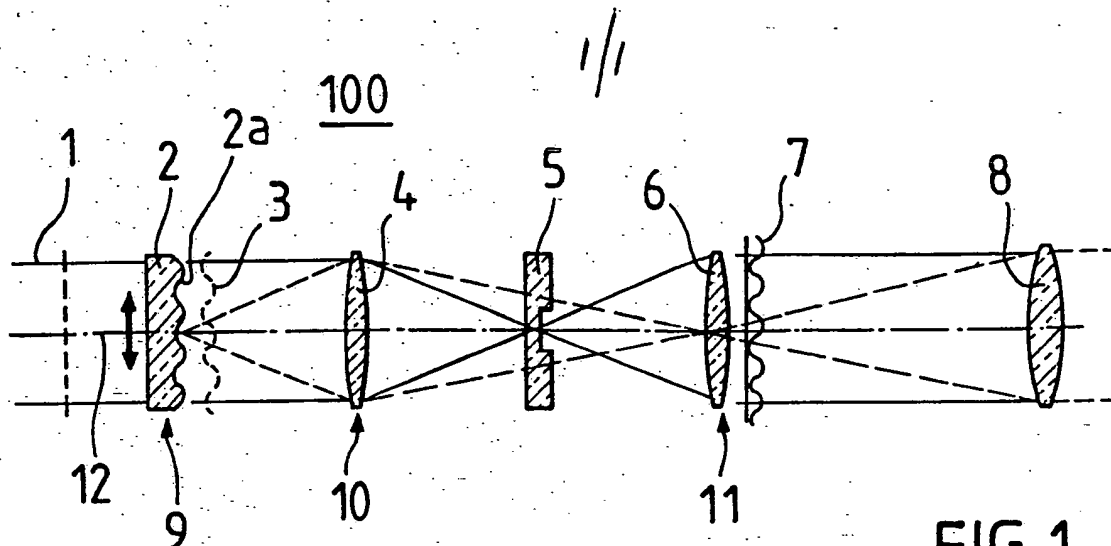


FIG. 1

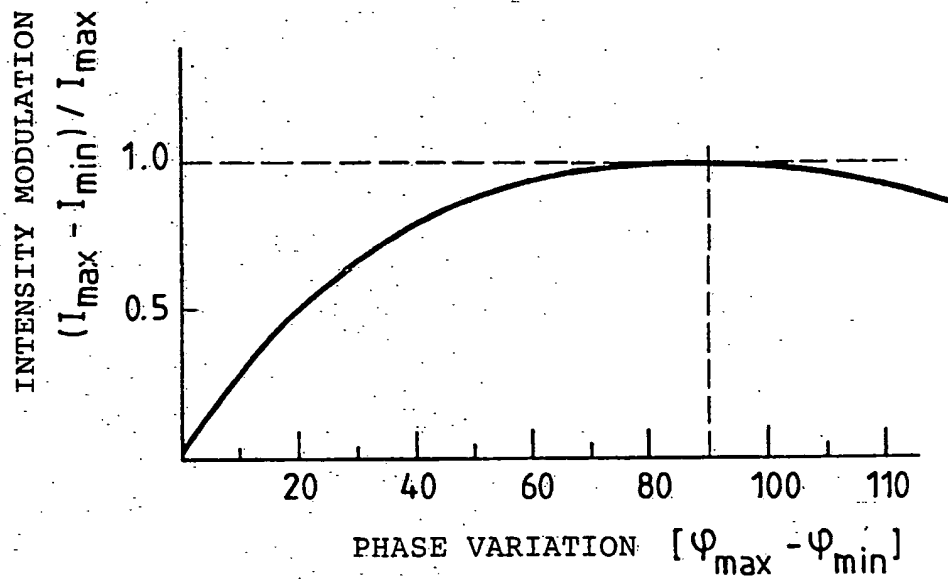


FIG. 2

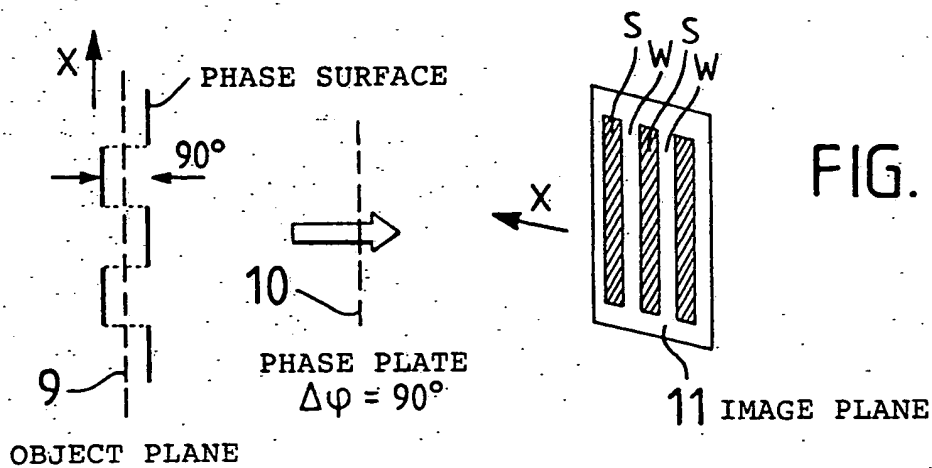


FIG. 3

A FLYING-BODY GUIDANCE SYSTEM

The invention relates to a flying-body, e.g. a missile, guidance system which uses an optical guide-beam projector working in accordance with the image-field-modulating guide-beam method.

Such guidance systems are known in various embodiments. In many instances they have taken the place of image-scanning guide-beam systems, because they ensure location of the flying body with high accuracy with relatively slight technical complexity. In this respect, scanning mirrors and scanning prisms rotating at high frequency are dispensed with in these guide-beam systems, and synchronisation between the various degrees of freedom of scanning are no longer necessary. Also the signal band width can be kept slight.

However, the image-field modulation processes which are used still have a considerable disadvantage in that only a slight intensity of the guide beam is available, due to the large angle of aperture of the guide-beam cone,

because the entire field of vision is simultaneously illuminated. This disadvantage is exacerbated by the fact that a considerable part of the optical transmitting power, typically close to 50%, is absorbed or reflected by the impervious zones of the modulator diaphragm and is thus not usable for the signal transmission.

The object of the present invention is to obviate the disadvantages of the prior art in the case of the type of missile guidance systems mentioned at the beginning hereof and to provide a guide-beam system in which the entire radiation power of the light source can be utilised to build up the spatial guide-beam pattern.

This object is achieved in that arranged movably in the laser beam path as modulator diaphragm is a phase diaphragm the phase profile of which is converted into an amplitude or intensity profile in the image plane of the projector optical system.

Further developments are indicated in the following description of an exemplified embodiment, the structure and function of which is shown in the accompanying drawing, in which:

Fig. 1 is a schematic representation of the structure of the optical system of the guide-beam projector;

Fig. 2 is a graph showing the variation in intensity modulation with respect to phase variation; and

Fig. 3 is a schematic diagram illustrating the conversion of a rectangular or square-wave phase profile into an intensity profile.

Fig. 1 shows an exemplified embodiment of the optical system 100 of the guide-beam projector of the invention in which, in accordance with the known 'per se' phase contrast process, without substantially power losses, the phase profile 3 impressed by the phase diaphragm 2 on the optical laser beam 1 is converted into an amplitude or intensity profile 7. The phase diaphragm 2 can, for example, be a transparent glass or germanium plate having a pre-determined pattern of variation in its optical thickness  $2a$ . This diaphragm 2 is illuminated coherently and thus uses the entire radiation power of the light source for the build-up of the spatial guide-beam pattern. With suitable choice of the optical thickness profile  $2a$  both of the phase diaphragm 2 and of a phase plate 5, which is arranged in the Fourier plane 10 of the objective together with an intermediate imaging lens 4, a completely modulated, high contrast amplitude or intensity profile 7 is produced in the image plane 11, where a field lens 6 is positioned. This means that the phase profile 3 which the phase diaphragm 2 produces is converted in the image

plane 11 into the intensity profile 7 and sent out by way of the projection objective 8.

The phase diaphragm 2 is movable in the beam path. If the phase diaphragm 2 is appropriately moved in a plane perpendicular to the beam axis 12, the intensity profile 7 of the guide beam 1 also moves. A receiver out in space can now determine, from the modulated signal received, its position in the guide-beam cone.

The quality of modulation and the contrast of the amplitude or intensity profile 7 is determined by the selected optical thickness profile 2a of the phase diaphragm 2 and of the phase plate 5.

The degree of intensity modulation in the image plane 11 is determined by the phase variation in the object plane 9.

Figs. 2 and 3 show the conversion of a rectangular or square-wave phase profile into an intensity profile so clearly that further explanations would seem to be superfluous.

It should additionally be mentioned that the optical thickness profile 2a of the phase diaphragm 2 and of the phase plate

$$(\Delta \varphi = \frac{\pi}{2}) \quad 5$$

can be produced, for example, by applying a specifically structured dielectric layer to a flat plate with the aid of epitactical and photolithographical processes.

As a result of the proposed flying-body steering system, intensity patterns can now be produced without the otherwise customary transmission losses at the diaphragm structure. Thus, with the same power of light source, a far higher signal-to-noise ratio at the receiver is achieved.

CLAIMS

1. A flying-body guidance system comprising an optical guide-beam projector which works in accordance with the image-field-modulating guide-beam method, characterised in that arranged movably in the laser beam path as modulator diaphragm is a phase diaphragm the phase profile of which is converted into an amplitude or intensity profile in the image plane of the projector optical system.
2. A system as claimed in claim 1 wherein the phase diaphragm is in the form of a transparent plate having predetermined variations in its optical thickness profile.
3. A system as claimed in claim 1 or 2 wherein the phase diaphragm is made from glass or germanium.
4. A system as claimed in claims 1, 2 or 3, wherein the guide-beam projector optical system has the movable phase diaphragm in the object plane, a subsequently arranged lens for intermediate imaging as well as a phase plate arranged in the Fourier plane, and a field lens arranged in the image plane.
5. A system as claimed in any preceding claim wherein the quality of modulation and the contrast of the ampli-



tude or intensity profile is determined by the selected optical thickness profile of the phase diaphragm and of the phase plate.

6. A system as claimed in any preceding claim wherein the degree of intensity modulation (intensity profile) in the image plane is determined by the phase variation of the radiation in the object plane.

7. A system as claimed in any preceding claim wherein the phase diaphragm is movable in a plane perpendicular to the beam axis.

8. A system as claimed in any preceding claim wherein the optical thickness profile of the phase diaphragm is produced by applying a specifically structured dielectric layer to a flat plate by means of epitactical or photolithographical processes.

9. A flying body guidance system substantially as hereinbefore described with reference to the accompanying drawings.